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Electric Water Heaters for Poultry

By

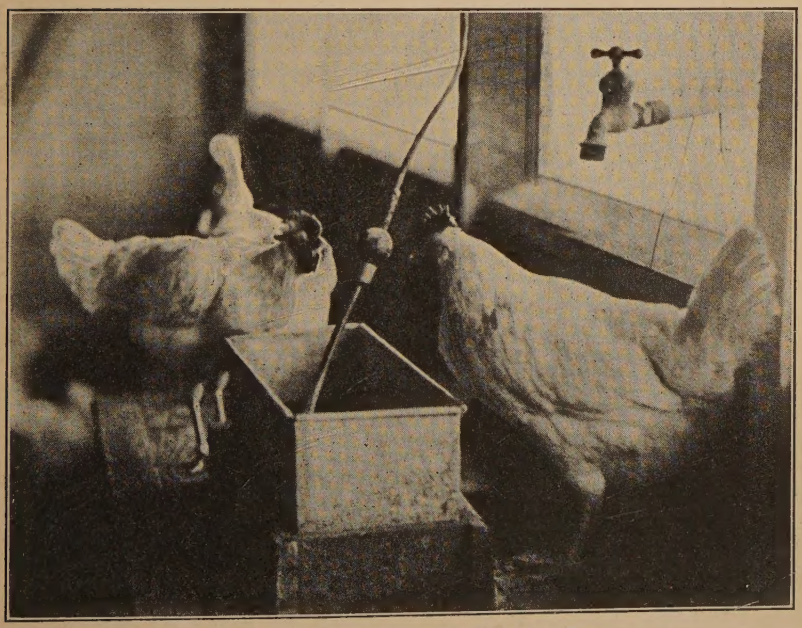
Geo. W. Kable and F. E. Fox

Oregon State Agricultural College Experiment Station

and

Oregon Committee on Electricity in Agriculture

Cooperating



Electric Immersion Heater in Drinking Pan.

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SUMMARY

Pullets drank 25.4 percent more warmed water than cold water during freezing weather.

Water consumption was increased 5 percent per pullet and 4.2 percent per hundred eggs laid by warming it during average Western Oregon winter weather. Temperatures were above freezing 90 percent of the time.

White Leghorn pullets laying at the average rate of approximately 60 percent in midwinter drank 0.26 pound of water per pullet per day and 44 pounds of water per 100 eggs laid.

Drinking water for poultry may be conveniently warmed with several styles of simple electric heaters at a cost about the same as for lighting two electric lamps.

Heaters of 75 to 100 watts capacity are about right for warming two gallons of water.

A 3-inch "clamp on" heater can be purchased for about $2.25. It would last indefinitely.

Specially constructed heaters to be immersed in the water can be secured for about $3.

In case of emergency a hermetically sealed electric soldering iron makes an excellent water heater.

Electric lamps may be used for water heating if they are supported close to the under side of the pan and both the pan and lamps protected to avoid heat losses.

Electric Water Heaters for Poultry

By

Geo. W. Kable and F. E. Fox

Poultrymen who are making a business of egg production are ever on the lookout for methods of increasing the monthly profits. A number of Oregon poultrymen, with this in mind, have been experimenting for several years with various means of warming the drinking water for their flocks during the cold days of winter. The heaters which were tried did not prove satisfactory. In response to a number of requests for information on the subject, an investigation was undertaken by the Experiment Station cooperating with the Oregon Committee on Electricity in Agriculture.

Suitable heaters can be obtained. Suitable electric heaters are very difficult to find on the market, the trouble with most of the commercial water heaters being that they require too much current and heat the water too hot. There are heaters made for other purposes, however, which may be adapted to heating small quantities of drinking water satisfactorily. Some of these are listed in Table III. As the demand for heaters increases, manufacturers will undoubtedly place special heating elements on the market for poultry house use.

Heaters tested under cold weather conditions. The original purpose of our investigation was to find heaters which offered promise and then test these out in the laboratory. The tests were first made in a refrigerated room where the temperature could be held at 20 degrees above zero. The heaters were then taken out into the laying houses and given a practical test during the cold weather of January and February. While making this latter test we were also able to get some information on the amount of water hens will drink when it is warmed and when it is cold.

Pullets drink more warm water. In testing out the heaters under house conditions four flocks of 115 White Leghorn pullets each were used. Two of the flocks were given warmed water and two were given water at tap temperatures. Each ten days the heaters were alternated so that each flock had warmed water for twenty days and cold water for twenty days. Table I gives the difference in the amounts of water consumed.

TABLE I. AVERAGE OF ALL FLOCKS FOR 40 DAYS

Temperatures				Pounds of water per bird per day	Pounds of water per 100 eggs laid	Water	Percent production
Outside air		Water					
Max.	Min.	Max.	Min.				
47.25	32.85	80.9	45.3	0.2665	44.9	Warmed	59.8
47.25	32.85	49.4	37.2	0.2537	43.1	Not warmed	59.6
Averages				0.26	44		59.7
Increase for warmed water				5%	4.2%		

During the forty days of the test there were two days when the temperature remained below the freezing point all day. On these days

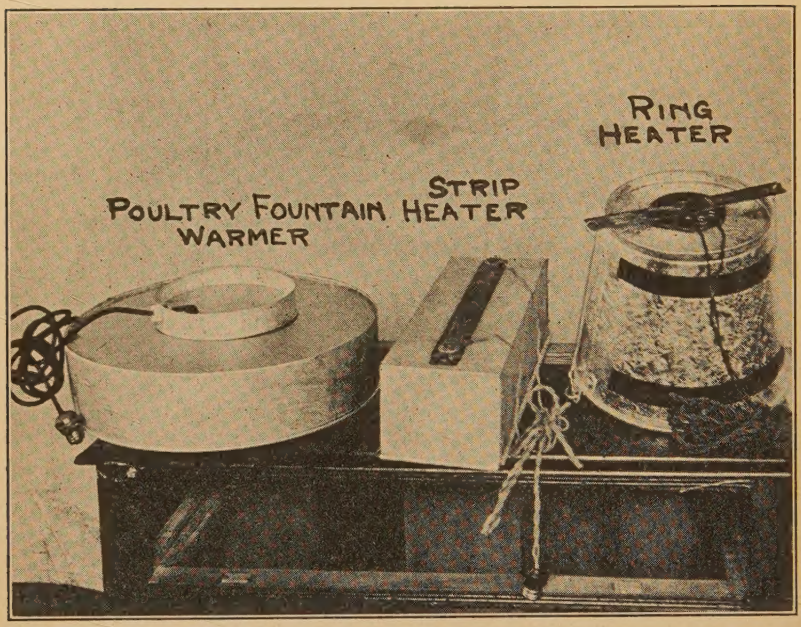


Fig. 1. Methods of applying external heaters.

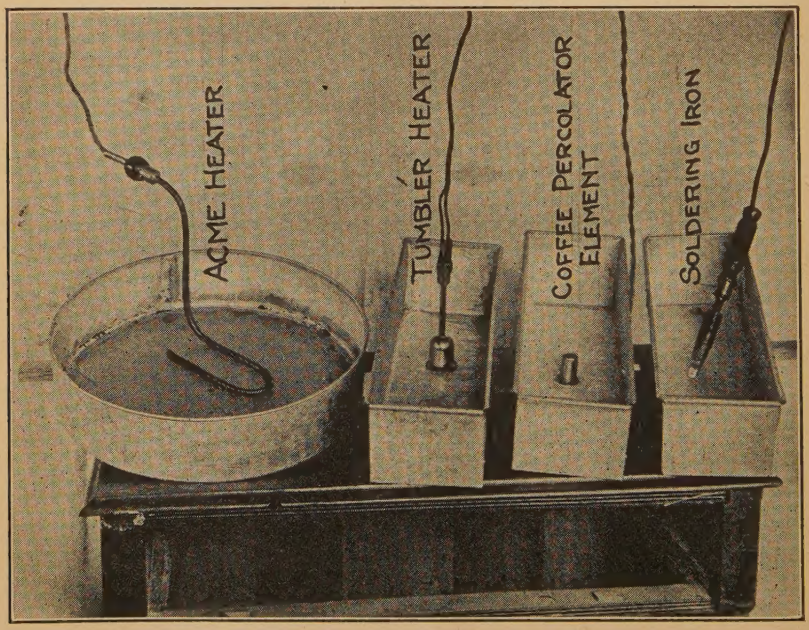


Fig. 2. Methods of using immersion heaters.

the heated pans were free from ice at all times, while the unheated pans were frozen over during the early morning hours before the poultryman arrived. The increase in the amount of warmed water over cold water consumed during these two cold days was quite marked, being 25.4 percent. The results of this test are shown in Table II.

TABLE II. RECORD FOR JANUARY 20-21 (FREEZING WEATHER)

House	Pounds of water per 100 pullets	Water temperature	Number eggs laid
21 A—Warmed—(lighted)	31.3	46 to 73	71
21 B—Cold (not lighted)	20.6	Freezing	54
22 A—Cold (lighted)	26.2	Freezing	65.5
22 B—Warmed (not lighted)	27.4	44 to 91	58
Average warmed	29.35		
Average not warmed	23.4		
Increased consumption of warmed water 25.4 percent.			

These preliminary tests, although not covering a long enough period to be conclusive, were carefully made and give an indication of what may be expected. The ten-day periods were too short to make a noticeable difference in physical condition or egg production.

Heaters save labor. Not the least advantage in the heating of water during freezing weather is the saving in labor. When a small amount of heat is applied continuously to the water, it never freezes, and the poultryman is saved the time and trouble of heating and carrying water.

Two types of heaters available. There are two general types of heaters on the market. "Clamp on" and other external heaters heat the water from the outside of the container in much the same manner as a small stove. (Three styles of external heaters are shown in Fig. 1.) Immersion heaters are placed directly in the water. (Four styles of immersion heaters are illustrated in Fig. 2.) Table III gives brief descriptions and approximate costs of the heaters which were used in our tests. This list includes all of the available styles of heaters which we considered suitable for the purpose.

All of the heaters described in Table III are standard equipment except the Acme Poultry Water Heater which was made up according to our specifications.

Merits of the two main types of heaters. *Immersion heaters.* Immersion units may be used in any open top container regardless of material or shape, such as wood troughs, pails, pans, or earthenware jars. (Percolator element cannot be so used.) Since the heater is immersed in the water all of the heat is transferred to the water. It is always ready to use by plugging into a lamp socket and it may be easily removed for cleaning the container.

Some of the disadvantages of this type are that it will burn out quickly if the pan becomes empty or if the heater is accidentally displaced or removed from the water while the current is on. The cost of these units is more than for external heaters, and because of their shorter life they cannot be recommended from a comparative economic standpoint.

TABLE IV. TEST

Test No.	Heater		Water container		
	Kind	Watts used[1]	Size	Insulation	Gallons of water
1	Tumbler	298	6½ x 19½ x 5	None	2
2	Tumbler	293	18″ diam. x 4″ deep	None	3
3	Percolator	83	6½ x 19½ x 5	None	2
4	Soldering Iron	97	6½ x 19½ x 5	None	2
5	Soldering Iron	105	6½ x 19½ x 5	1″ wood box	2
6	Soldering Iron	101	12 qt. pail	None	2
7	Acme	67	6½ x 19½ x 5	None	2
8	Acme	69	6½ x 19½ x 5	3″ of shavings	2
9	Acme	71	6½ x 19½ x 5	3″ wet shavings	2
10	Acme	79	6½ x 19½ x 5	None	2
11	Ring	111	6½ x 19½ x 5	None	2
12	Ring	105	12 qt. pail	None	2
13	Ring	108	12 qt. pail	3″ of shavings	2
14	Strip	83	6½ x 19½ x 5	None	2
15	Strip	86	6½ x 19½ x 5	1″ wood box	2
16	3 16 c.p. carbon lamps	143	6½ x 19½ x 5	1″ wood box	2
17	3 16 c.p. carbon lamps	147	6½ x 19½ x 5	1 side of box removed	2
18	2 16 c.p. lamps	115	6½ x 19½ x 5	1″ wood box	2
19	Smith Brothers fountain warmer	17	12 qt. pail	None	2
20	Smith Brothers fountain warmer	18	12 qt. pail	None	2
21	Check—No heat	----	18″ diam. x 4″ deep	None	3

[1]Approximate power consumption for first 4 hours of test. Power used increased with increasin

[2]Water temperatures taken with thermometer stems entirely submerged 1¼″ below water surfac

[3]Thermal efficiency $= \frac{\text{Increase in temp. x pounds water warmed}}{\text{Kwh. used x 3412 (Btu per Kwh.)}}$. The thermal efficiency give relative efficiencies of the heating units alone.

[4]Kwh. stands for kilowatt hour, which is the unit of quantity of electricity. The cost per kwh.

VATER HEATERS

	Water Temperatures[2] °F.									Evaporation in 24 hours.	Increase in temperature in 4 hours. °F.	Approximate thermal efficiency for first 4 hrs.[3]	Electricity used in 24 hr. day.
	Start	15 min.	30 min.	1 hr.	2 hrs.	4 hrs.	5 hrs.	7 hrs.	22 hrs.				
										in.		%	*Kwh.*[4]
°	44	58	71	87	111	127	130	-----	-----	----	83	34.2	7.2
	47	60	63	75	85½	99	-----	97	96	----	52	32.6	7.0
	47	50	53	57	60	67	-----	68	80	.48	20	28.8	2.0
	47	50	53	59	65	75	-----	77	89	.55	28	35.2	2.3
	44	46	52	59	70	79	-----	82	82	----	35	40.8	2.5
	48.5	50	53.5	58	66	76.5	79	80.5	93	----	28	34.4	2.4
	47	48	50	52	55.5	61	-----	62	76	.24	14	25.4	1.6
	45	48	50	54	60	70	74	-----	87	----	25	43.8	1.7
	44	46.5	49	53	61	68	-----	73	82	----	24	40.5	1.7
	61	64	68	73	81	90	-----	95	97	----	29	44.4	1.9
	46	49	52	57	65	73	-----	76	86	----	27	29.4	2.7
	47.5	49	53	57	60	75	-----	78	96	.82	27.5	32.1	2.5
	48	51	56	62	74	92	99	103	-----	----	44	50.0	2.6
	47	48	49	52	54	59	-----	59	74	.27	12	17.8	2.0
	45.5	47	49	52	59	69	72.5	74	87.5	----	23.5	33.8	2.1
	41.5	42.5	45	49	57	68.5	72.5	74	88.5	----	27	23.2	3.4
	43	43	43	44.5	47	48	-----	49	60	----	5.5	4.6	3.5
	63	64	65	67	-----	70	-----	71	-----	----	7	7.5	2.8
5	44	43	42.5	41	39	frozen over		-----	-----	----	-----	-----	.4
5	59	59	60	61	61			-----	62	----	-----	-----	.4
	45	42	40	39	36	⅛" ice	frozen over		1½" ice	----	-----	-----	----

tage at night.

lbs half-way from heaters to far ends of pans.

to the entire unit, including heating element, container and insulation and is not a measure of the

varies from about 2c to 10c.

TABLE III. DESCRIPTIONS OF POULTRY WATER HEATERS TESTED

Name or Kind	Size or number	Rating Volts	Rating Watts	Watts used by test	Approximate cost
Universal Immersion (Tumbler) Heater,[1] Immersion type	No. E 970	115-120	300	298 w. @ 106 v.	$5.00
Vulcan Soldering Iron,[2] Immersion type	No. 500 11⅜" long	120	120	96.5 w. @ 104 v. 117 w. @ 115 v.	$9.00
Hotpoint Coffee Percolator Element,[3] Immersion type	⅞" diameter x 1½" high	220	400	81 w. @ 100 v.	$2.50 without cord and plug
Acme Poultry Water Heater,[4] Immersion type	⅜" bent copper tube	120	100	68 w. @ 105 v.	$3.50
Chromalox Strip Heater,[5] Clamp On type	18"x1½"	220	375	83 w. @ 104 v. 101 w. @ 115 v.	$2.50 without cord and plug
Chromalox Ring Heater,[5] Clamp On type	4" outside diameter	220	500	108 w. @ 106 v.	$2.10 without cord and plug
Smith Bros. Electric Water Fountain Warmer,[6] Plate type	8¼" diam. 1¼" high	120	13.9	16.8 w. @ 109 v.	$2.50
Three Electric Lamps		120	16 c.p.	147 w. @ 108 v.	$2.60

[1]Furnished by Portland Electric Power Company, Portland.
[2]Purchased from Stubbs Electric Company, Portland.
[3]Purchased from Hotpoint Service Station, Portland.
[4]Made to order by Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
[5]Furnished by Edwin L. Wiegand Co., 422 First Avenue, Pittsburgh, Pa.
[6]Furnished by R. Roy Putman, Clackamas, Oregon.

External heaters. External heaters are relatively easy to apply to most metal containers; they will not burn out if the pan becomes empty; fowls will not displace them; the cost is comparatively low and the better styles are efficient heaters.

If "clamp on" heaters are placed on the bottom of a pan, they interfere with placing the pan on a flat surface and some other means of support such as a slatted frame or a board with a hole cut in it must be provided. The heaters should be kept away from inflammable material for the sake of safety from possible fire.

Size of heater to use. In starting this investigation the requirements set down for a satisfactory heater were that it should be simple, inexpensive, easy to apply, low in operating cost, and should keep the water from freezing without overheating it. Thermostatically controlled heaters were eliminated because of their high first cost and complexity. In order to meet the above requirements, especially in regard to temperatures, our tests indicate that heaters of the following sizes should be used.

For Central and Eastern Oregon (-15° to 40° F.)
80 to 100 watts for 2-gallon container
120 to 150 watts for 3-gallon container
160 to 200 watts for 4-gallon container

For Western Oregon (0° to 50° F.)
60 to 75 watts for 2-gallon container
80 to 100 watts for 3-gallon container
120 to 150 watts for 4-gallon container

If only one size is available, we recommend the 75-watt size.

The above capacities are an approximate guide only. The temperature of the water will depend upon the shape and size of the container, its insulation against cold, its location, and the temperature of the poultry house, as well as on the wattage of the heater.

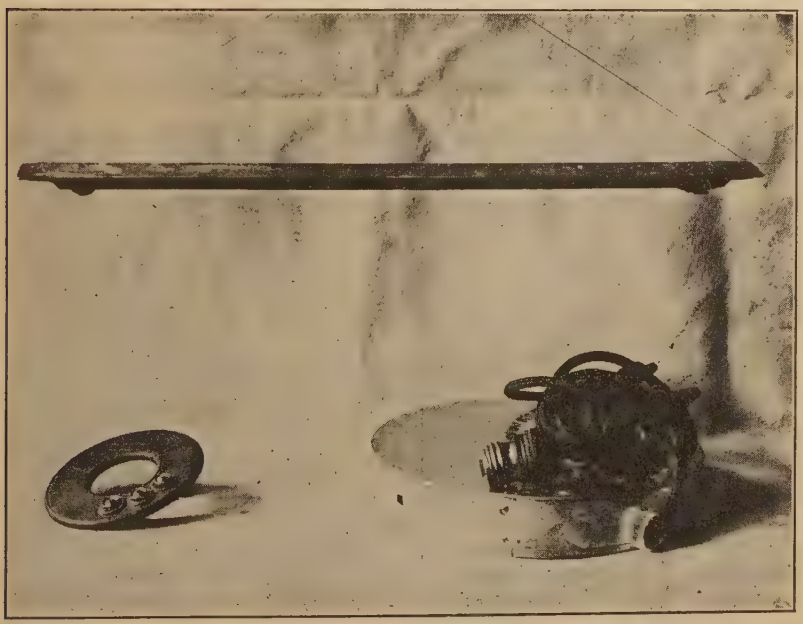


Fig. 3. Chromalox strip heater above; ring heater at left; Smith Poultry Fountain Warmer at right.

When using electric lamps for heat the above capacities should be increased 50 percent.

Boxing the containers closely with one-inch boards will conserve enough heat so that the above standards may be decreased 25 percent. If insulated with two inches of shavings, the decrease will be 40 percent.

Heaters should be of the correct voltage for your line. A 110-volt heater used on a 120-volt line will produce an excess of heat and will have a shorter life.

220-Volt heaters may be used on 110-volt line. When it is not possible to secure 110-volt heaters in desired wattage ratings, 220-volt heaters

may be used on 110-volt circuits. When using a 220-volt heater on a 110-volt circuit, the watts used and the heat produced are both divided by four. Example: A heater is desired to use 100 watts on a 110-volt circuit. Either a 100-watt, 110-volt heater or a 400-watt, 220-volt heater may be used. *Caution:* Never use a 110-volt heater on a 220-volt circuit. It will burn out.

Small heaters may be used on large pans. It is not necessary to have heaters of large dimensions to use on pans of large size; nor is it necessary to place the heater in the center of the pan to warm the water uniformly. A small heating element placed at the bottom of one end of a long pan or of the side of a large pan will heat the water at the opposite end or side as warm as that adjacent to the heater.

There may be as much as ten to fifteen degrees difference between the temperatures at the top and at the bottom of the pan, but the surface temperature of the water will be reasonably uniform.

Comments on different styles of heaters. The ring heater shown in Fig. 3 is perhaps the most satisfactory unit which we tested. It is flat and may be wired to the container or fastened with a piece of strap iron as shown in Fig. 1. The single-heat, three-inch size which we recommend will cost approximately $2.25 with attachment cord and plug.

The Acme heater illustrated in Fig. 4 is a very satisfactory unit of the immersion type. Heaters of this kind are not now on the market but may be purchased from manufacturers on special order. The heating part of the unit should rest on or close to the bottom of the pan and be heavy enough to make it stable. The handle may be made to hook over the rim of the container or it may be made long enough to extend above the water in the deepest container which will be used. Such a unit should cost about $3 complete.

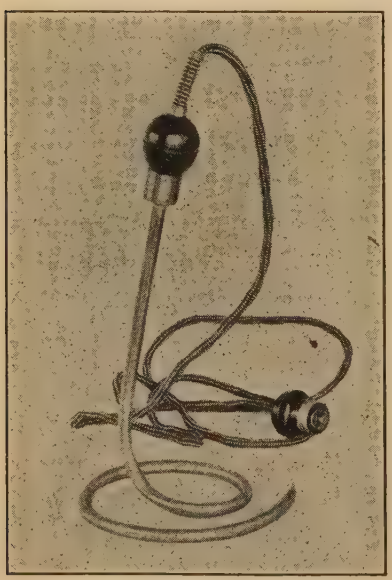


Fig. 4. Acme immersion heater.

Hermetically sealed soldering irons make very convenient water heaters in addition to being useful for soldering. Only hermetically sealed irons may be immersed in water. The cost of such irons is from $6 to $10 each, which is too high for general use.

Electric lamps held close to the bottom of a pan and with pan and lamps enclosed in a box to conserve heat (as shown in Fig. 6) make a reasonably satisfactory heating device. Disadvantages of the lamps are that they have a rather short life under continuous use and the operating cost is about fifty percent higher than for other types of

heaters. They have the advantage, however, of being adjustable over a wide range of temperatures by changing the number and size of lamps used.

A number of poultrymen have attempted to warm water with lamps by immersing them directly in the water. This method would be efficient and entirely satisfactory if simple waterproof lamp receptacles were available. We know of no such receptacles at the present time.

The strip heater illustrated in Figs. 1 and 3 is similar to the ring heater described above except in shape. Because of its greater exposure to the atmosphere it did not heat the water as efficiently as the ring element.

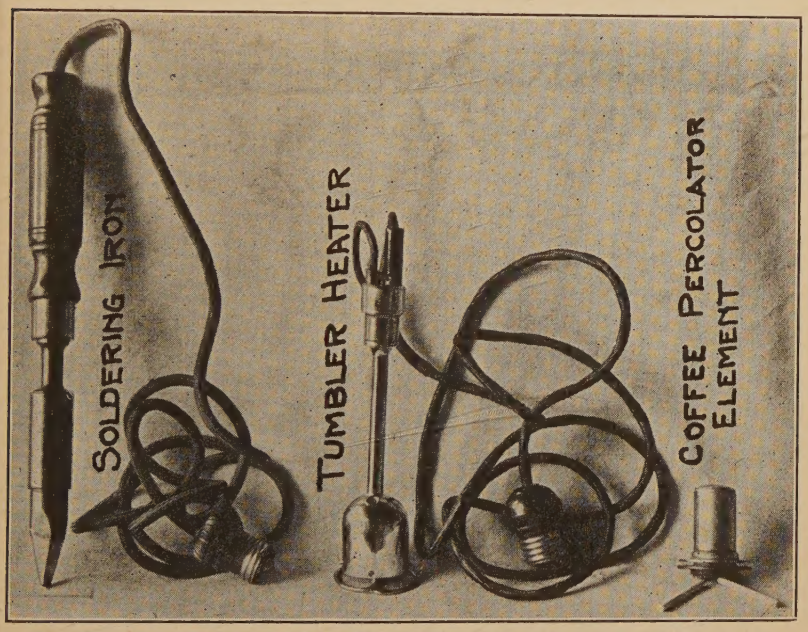


Fig. 5. Types of immersion heaters.

Tumbler heaters will heat the water efficiently if they can be secured in sufficiently low wattage and held in place in the container. Most of them retail at $5 each. See Figs. 2 and 5.

Coffee percolator elements are suitable only for permanent installations. They are small, efficient, and not in the way, but they must be attached permanently to the water pan by an electrician. They are shown in Figs. 2 and 5.

The Fountain warmer illustrated in Figs. 1 and 3 was of too low wattage to keep two gallons of water from freezing.

ADDENDUM

The information on the following pages is added for the benefit of those who may be interested in more of the details of our water heater tests.

Plans of tests. Heater tests were made in a refrigerated room and under conditions approximating those of an Oregon winter. In each test the rate of heating, the maximum temperatures attained, and the efficiency of the heating unit were observed or computed. Tests Nos. 10 and 18 (see Table IV) were made for the special purpose of determining the maximum temperatures reached by continuous heating under conditions similar to a warm winter day.

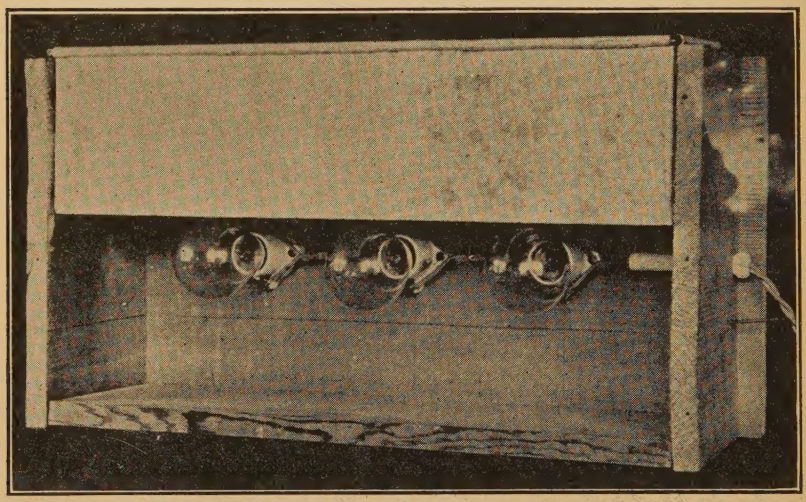


Fig. 6. Side view of lamp heater with side of box removed to show arrangement and wiring.

The effect of insulating the pans from the cold air was observed in tests 5, 8, 9, 13, 15, 16, 17, and 18. The insulation in tests 8, 9, and 13 consisted of fine planer shavings. The pail in test 13 was placed in a box 12½ by 13½ inches, which gave an average insulation of about 2 inches. The pan in the other two tests was insulated with 3 inches of shavings on the sides and 1 inch on the bottom and ends. It was assumed that if shavings were used for insulation, they would sooner or later become wet, which prompted test 9. The wood boxes used for insulation were similar to that shown in Fig. 6. They fitted closely about the pans and supported the pans at a proper drinking height.

The Universal tumbler heater used in some of the tests on heat distribution was hollow and had openings at top and bottom which stimulated convection currents and probably influenced the results.

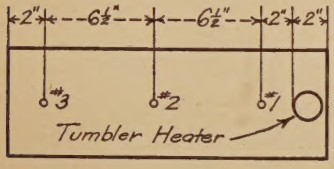
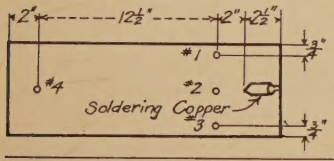
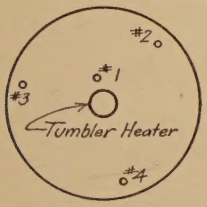
Study of effect of location of heating element on uniformity of heating in water pans.

Air temperatures: 15° to 24° F.

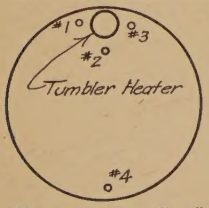
Containers of shape and size indicated in sketches.

Rectangular pans contained 2 gallons of water; circular pans contained 3 gallons.

All thermometers submerged 1¼ inches below water surface unless otherwise noted. Thermometer positions noted by figures on sketches.

Plan sketches of pans showing location of thermometers	Thermometer No.	Water temperatures — °F. Start	15 min.	30 min.	1 hr.	2 hr.	5 hr.
	1	44	55	69	85.5	111	130
	2	44	58	71	87	111	130
	3	44	61	72.5	88	112	130
	1	44	46	52	59.5	70	-----
	2	44	46	52	59.5	70	-----
	3	44	46	52	59	70	-----
	4	44	47	50	59	70	-----
	1	51	54	60	71	82	-----
	2	51	57	65	74	84	-----
	3	51	55	63	73	83	-----
	4	51	57	65	74	84	-----

Pan 18″ diam.
Thermometer No. 1, 2″ from heater.
Others, 2″ from edge.



Thermometers all 1″ from heater or from edge of pan.

Thermometer number	1	2	3	4
	Water temperatures °F.			
Start 1/16″ ice on pan	32	32	32	-----
After 15 minutes	38	38	38	-----
After 65 minutes	65	66	----	68
After 2 hrs. thermom. ⅜″ from bottom	67.5	67	----	68.5

Water stirred up and cooled to uniform temperature of 58°. Thermometers placed at position No. 4, ¼″ from bottom, ¼″ from surface and at half depth. After one hour temperatures were: ¼″ from top, 83; center, 77; ¼″ from bottom, 69.